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Abstract

A large variety of energy-efficiency policy measures exist. Some are mandatory, some are informative, and some use financial incentives to promote diffusion of efficient equipment. From country to country, financial incentives vary considerably in scope and form, the type of framework used to implement them, and the actors that administer them. They range from rebate programs administered by utilities under an Energy-Efficiency Resource Standards (EERS) regulatory framework (California, USA) to the distribution of Eco-points rewarding customers for buying highly efficient appliances (Japan). All have the primary objective of transforming the current market to accelerate the diffusion of efficient technologies by addressing up-front cost barriers faced by consumers; in most instances, efficient technologies require a greater initial investment than conventional technologies. In this paper, we review the different market transformation measures involving the use of financial incentives in the countries belonging to the Major Economies Forum. We characterize the main types of measures, discuss their mechanisms, and provide information on program impacts to the extent that ex-ante or ex-post evaluations have been conducted. Finally, we identify best practices in financial incentive programs and opportunities for coordination between Major Economies Forum countries as envisioned under the Super Efficient Appliance Deployment (SEAD) initiative.

Introduction

Many studies have demonstrated that the penetration of energy-efficient equipment is far below the level that is cost effective for energy consumers (IPCC 2007, McNeil 2008). The gap between a consumer's actual investments in energy efficiency and the investments that appear to be in the consumer's interest is the rationale for energy-efficiency policies (Golove and Eto 1996). Energy-efficiency policies' main role is to identify the market barriers that cause this gap and develop measures to overcome these barriers. Market barriers are diverse and can include behavior, information, transaction, financing, institutional, and regulatory issues or structures that make investment in and adoption and implementation of energy-efficiency measures and technologies difficult, slow, or expensive. A complete description of market barriers is available in the reviews by Sathaye and Murtishaw (2004) and more recently Jollands et al. (2010). One of the most significant market barriers identified is the relatively higher up-front costs of efficient products.

Financial incentives (FIs) address market barriers that generally result in under-investment in energy efficiency, either because of the higher up-front cost of energy-efficient products or the higher overall cost. Additionally, by promoting more energy-efficiency equipment to customers, FI programs increase consumer knowledge about future savings potentials. Inclusion in an incentive program also confers credibility on a technology (Koomey and Richey, 1998).

In parallel to removing barriers, FIs remedy some market imperfections. In many instances, the energy costs faced by consumers are lower than the costs incurred by the energy sector or society as a whole because costs of many environmental and social externalities are not included in consumer costs. Further, the marginal cost of energy is typically lower for consumers than for the energy sector.[1] Therefore, when consumers save energy, they do not capture all the benefits that savings represent for the energy sector and society as a whole. As a result, consumers invest suboptimally in energy conservation. Financial incentives to consumers are one of the options to correct weak consumer incentives for adopting energy efficiency measures and to correct for under-investments in efficiency.

Moreover, FIs have also been implemented by many governments to either accelerate the market penetration, cost reductions from economies of scale and 'learning by doing' of new and more efficient technology or/and to boost the economy by increasing customer spending and creating jobs.

This paper reviews FI incentives from across the world. We explore examples of programs implemented in different countries in order to further legitimize the concept, to inform countries or states that are interested in implementing similar programs, and to offer program design insights related to different aspects of the implementation process. The paper does not attempt to provide a comprehensive review but highlights selected ongoing policies and programs that are overcoming market barriers in the buildings sector of the U.S., Japan, Korea, Brazil, South Africa, India, China, and European countries. The paper also notes key issues that need to be addressed if these programs are replicated in other countries.

The research presented in this paper aims to provide insights that will help accelerate the adoption of highly efficient appliances and equipment. The research is part of the Super Efficient Appliance and Equipment Deployment (SEAD) Initiative which was launched in July 2010 during the first Clean Energy Ministerial. At the ministerial, ministers from 14 countries[2] pledged to carry out joint efforts to dramatically improve the energy efficiency of household appliances and other energy-consuming equipment. Financial incentives programs are being reviewed under the SEAD initiative to assess how these measures can best be used to accelerate deployment of super-energy-efficient appliances and equipment as well as to identify areas of international cooperation.[3]

This paper reviews FIs that impact the penetration of home electric appliances and equipment. The first section of the paper describes regulatory approaches that underlie implementation of FI programs. Next, the paper reviews cost recovery mechanisms. The third section describes the major actors that administer financial incentive programs and provides an overview of their characteristics. The fourth section depicts the different types of FI measures implemented in various countries. Finally, the last section explains the role of evaluation and describes experiences across countries.

[1] Consumers mostly pay based on average cost of energy even for their marginal consumption the marginal cost of acquiring new energy sources is typically higher than the average cost of energy.

[2] Participating governments include Australia, Canada, the European Commission, France, Germany, India, Japan, Korea, Mexico, Russia, South Africa, Sweden, the United Kingdom, and the United States.

[3] For more information on the SEAD program see: http://www.cleanenergyministerial.org/SEAD/index.html

Regulatory Approaches

Financial incentives have been used by many countries since the mid-1970s to accelerate the penetration of more efficient appliances. Policy makers have employed different strategies. The two most common are FIs that are provided directly by government and FIs issued by utilities or third parties based on a regulatory mandate.

Government Measures

FI programs that are directly implemented by the government are generally designed to spur learning-by-doing and to increase returns on investment in order to fuel long-run growth of this market and lead to its technological maturity. In economic recessions, budgetary spending is also used to boost economic activity and stimulate the creation of jobs in energy efficiency and related sectors. Energy efficiency has been recognized as playing a notable role in stimulating investment and creating jobs.

The most common forms of government programs include tax credits or deductions and subsidized (i.e., low-interest) loans. Other FI programs can be used to stimulate customer spending. These types of FIs include early replacement programs, in which the government subsidizes replacement of old appliances with new more efficient ones or attributes rewards points to consumers who purchase energy-efficient appliances; the points can be exchanged for consumer products later on.

Recently, governments across the world took decisive action to address the 2008 financial crisis. The U.S. Department of Energy funded $300 million through the American Recovery and Reinvestment Act (ARRA) of 2009 in rebate programs to consumers who purchased qualifying ENERGY STAR home appliances. Each state received an amount proportionate to its population and is responsible for developing and implementing rebate programs (MacRae et al. 2010). Another example is the Eco-Point System launched by the Japanese government in 2009 as part of Japan's stimulus package. This program grants "eco-points" for the purchase of consumer products that rate four or more stars in the national system of energy-efficiency standards. By the end of June 2010, the government had granted 246 billion eco-points, equivalent to 246 billion yen ($2.6 billion USD[4]) (METI 2010).

However, government stimulus funding tends to be short term and therefore not a steady source of support for energy-efficiency programs. Temporary action can sometimes have reverse effect, for example rushing consumers to buy appliances that they would not have bought in the absence of the financial incentives so that they can cash in before the funding availability expires. Moreover, ad hoc budget allocations rarely match the amount needed to overcome market barriers. The budget allocations for energy efficiency are rarely based on a careful review of the amount that would be necessary to give the right impetus for adoption of energy-efficiency measures but results from political decisions.

Energy Provider Targets

The approach of setting a quantified target for energy efficiency aims to stimulate the implementation of energy-efficiency measures and efforts to reach goals fixed by regulators. Energy providers are required to meet annual energy saving targets by undertaking activities directly or contracting with appliance retailers, energy-efficient equipment suppliers, or energy service companies (ESCOs). In most cases, the targets provide an obligation to achieve a specific level of energy savings and are based on energy-efficiency potential studies (ACEEE, 2011). Targets are then either expressed as a percentage reduction in total energy sales, a reduction in growth of energy usage, or an absolute value. The required reduction can be expressed in annual energy usage and coincident peak demand, primary energy units, or emissions of carbon dioxide. In other cases, targets require energy providers to spend a predetermined share of their annual revenue on energy efficiency measures. Below we present and describe four types of energy provider targets implemented in different countries..

Energy-Efficiency Resource Standards (EERS)

The United States has three decades' experience in carrying out local and state energy-efficiency programs. Traditionally, U.S. utilities were required to conduct Integrated Resource Planning, also called least-cost resource planning. Integrated Resource Planning requires that utilities plan for future needs by considering and assessing

[4] 2009 exchange rate of 93.57 Yen per US$ (OECD, 2009)

benefits of demand-side management (DSM) programs. However, DSM spending dropped dramatically (50%) during the 1990s after U.S. electricity industry restructuring (Nadel and Kushler 2000). To promote DSM activities again, U.S. states now stipulate financial incentives. A different program strategy, “market transformation,” was also introduced to supplement objectives of existing energy-efficiency programs. (Blumstein et al. 2003). Energy-efficiency resource standards (EERS) are state policies that require energy providers and other entities delivering energy-efficiency programs to meet specific energy savings targets according to a set schedule. About 24 U.S. states have passed EERS. The highest EERS are in Vermont and Massachusetts, which require around 2.5 percent savings annually. In California, which has a fast-growing population, the savings targets are 23 billion kilowatt-hours (kWh) with peak demand reductions of 4.9 million kilowatts (kW) by 2013. The California Public Utilities Commission (CPUC) in 2009 approved $3.1 billion in funding for energy-efficiency programs, which is 42% more than in the prior three-year cycle (CPUC 2010).

In November 2010, China also adopted EERS in the form of national energy-efficiency regulations that require China’s power grid companies to save energy equivalent to at least 0.3% of their sales volume and 0.3% of maximum load compared with the previous year (Finamore 2010). The new regulations came into effect on January 1, 2011 with possible sources of funding coming from a rate surcharge applicable to all, a rate surcharge differentiated by customer categories, or/and government budget allocations (Finamore 2010). These new regulations are in part the outcome of tight collaboration between the state of California energy-efficiency experts and a few provinces in China. China uses the term Efficiency Power Plant (EPP) rather than DSM to describe a virtual power plant that delivers "negawatts" through a portfolio of DSM or energy-efficiency projects.

Cap and Trade Mechanisms

In some cases, efficiency targets are accompanied by trading markets (e.g., white certificates). The efficiency target can be met by purchasing the corresponding white certificates on the market. White certificates represent energy savings in a specific unit, which can differ widely among countries and states. The obligation can touch different sectors. For example, efficiency obligations in the UK scheme can only be met with savings achieved in the residential sector. In contrast, France recently extended the second phase of its white certificate scheme to include the transport sector. Obligations can also include targets attributable to specific sectors. For example, 50% of the energy savings target in the UK scheme has to be met in low-income households.

Several European countries have implemented a white certificate scheme or are seriously considering doing so. The UK was the first European Union country to implement an obligation scheme for household energy savings, in 2002. The current obligation requires domestic energy suppliers to save 154 megatonnes of carbon from 2008 to 2011. Italy started a five-year white certificate scheme in January 2005. About one-third of the savings were in electricity, and as much as 75% of the savings originated from energy services companies (ESCOs). More than 60% of total savings were achieved in the commercial and household sectors. The first phase of the French white certificate program ran from 2006 to 2009 with a target of 54 terrawatt hours of cumulative energy savings from oil, gas, and electricity. Two-thirds of the savings were achieved from installation of energy-efficient heating systems, about 15% were achieved through building envelope improvements, and only 3.4% were achieved from installation of efficient electrical equipment (mainly variable speed drives and low-energy lighting) (French Ministry of Sustainable Development 2009).

New South Wales in Australia implemented the first mandatory greenhouse gas (GHG) emissions trading scheme in the world in 2003. Under the GHG Reduction Scheme indirect GHG emissions associated with electricity sales are capped every year, and electricity retailers have to submit certificates to partially offset the emissions associated with their electricity sales. In 2007, more than 40% of the 24.8 million certificates created were the result of DSM programs (IPART 2008). Two other Australian states, South Australia and Victoria, have implemented GHG-reduction targets that can be met only through energy-efficiency activities in the residential sector. In 2009, the New South Wales government modified the GHG Reduction Scheme so that energy-efficiency projects are no longer eligible and created a new market specifically dedicated to Energy Savings Certificates (IPART 2010).

Standard offer

In May 2010, the South African Department of Energy provided a framework for the development of the Energy Efficiency and Demand-side Management Program. The Minister of Energy established a quantitative, long-term energy savings target that must be met by implementing energy-efficiency programs. The National Energy

Regulator, NERSA, then set a standard offer purchasing rate based on the avoided cost of new generation. The standard offer purchasing rate, expressed in Rand /kWh or Rand/kW, represent the rate offered to acquire energy savings. It reflects the utility's marginal cost to acquire more capacity. The regulator also ensures that a cost-recovery mechanism is in place for the utility. This is done through the Energy Efficiency Demand Side Management allowance, which corresponds to a public benefit charge. ESCOs, equipment suppliers, and other organizations that can deliver electricity savings at predetermined rate are eligible to submit projects and be paid once the projects have been implemented and the savings have been certified by an authorized evaluation organization.

Utility Investment Target

In a few cases, notably Brazil's program, the savings target is not set based on energy-efficiency savings but on utility revenues. The Brazilian power regulatory authority, ANEEL, mandates that utilities invest at least 0.5% of their net revenues in energy-efficiency programs through a wire charge. This measure has been in place since 1998. ANEEL establishes regulations for how the wire charge funds can be used, and utilities are responsible for designing and executing energy savings programs (Taylor et al. 2010). The Brazilian Congress mandates that about half of these funds must be spent on energy-efficiency measures targeted at low-income households. According to Taylor et al. (2010) investments of the wire charge funds about five times greater than investments by PROCEL, the government program for energy efficiency in the electricity sector. ANEEL influences the wire charge programs in two ways. First, annual guidelines determine what portion of wire charge revenues goes to energy-efficiency programs and what portion goes to research and development (for example, in 2007, 50% of wire revenue charges went to energy-efficiency measures). Second, ANEEL approves the programs that utilities propose to fund with wire charge revenues.

Cost Recovery

Implementation of a transparent cost-recovery mechanism is an essential part of a successful energy-efficiency program. Moreover, program financing needs be sustained and sufficient to achieve the goal originally set.

Government Funding

Governments programs are generally funded by taxpayers. The government can decide to allocate part of its annual budget to support and encourage the penetration of efficient equipment. Financing can also come from stimulus funds, for example ARRA in the U.S. mentioned above.

In other cases, government programs can be funded with capital raised through bonds. A government bond is a debt instrument that yields a low and fixed interest rate. Financing costs are covered by the energy saved by the energy-efficiency measures implemented under the program.

Energy-efficiency programs can also be financed through the establishment of taxes on specific products, with the revenue directed to FI programs. For example, Korea introduced a 6.5% tax penalizing high-consuming or large appliances. The appliances covered by this tax include televisions bigger than 40 inches, refrigerators consuming more than 40 kWh per month, large fans, drum washers using more than 720 kWh per month, and air conditioners using more than 370 kWh per month (IEA 2010). The tax is effective from April 2010 to December 2012, and the tax revenues will be used to support social welfare facilities such as orphanages to replace outdated appliances with high-efficiency ones.

Ratepayer-Funded Mechanisms

Ratepayer-funded mechanisms include programs that are either explicitly or implicitly paid for by ratepayers. Explicit mechanisms charge a defined amount as part of the consumer electricity rate, and implicit mechanisms require utilities to meet target savings by spending a share of profits on energy efficiency. Under ratepayer-funded mechanisms, the costs of measures are recovered through tariffs, levies on electricity tariffs, or the creation of ad hoc markets where saving certificates can be traded.

Public Benefits Charges

A large number of countries apply a small levy or charge – a fraction of a cent per kWh – on electricity sales. These levies finance a common public fund that supports energy-efficiency programs. The rationale is that the cost to customers from the increased electricity rate is compensated by savings on their monthly bills from energy-efficiency improvements. The revenues from the charges are therefore redirected entirely back to customers. This approach raises rates initially but provides a price signal that encourages investment in energy efficiency and generates revenue which is earmarked to fund energy savings. The efficiency investments result in lower rates because they prevent or delay capital investments in generation capacity. In other words, customers invest at the time of electricity purchase but recover the extra costs through electricity savings.

These types of public benefits charges have been implemented in 22 U.S. states (DSIRE database, 2011). Implementation of these programs in the U.S. resulted from the decrease in energy-efficiency investment by utilities after electric utility restructuring in the late 1990s. These charges have been implemented to ensure continued and transparent support for energy-efficiency and low-income energy programs (Eto, 1998). The value of the charges ranges from $0.00003 to $0.003 per kWh with a median value of about $0.0011 per kWh. Utility spending on energy efficiency represents between 0.7% and 3% of total utility retail revenue (Kushner, York, and Witte 2004). This generated a total annual budget of $5.4 billion in 2010 for public-benefit-charge-funded electricity efficiency program across all U.S. states (Caracino 2010).

In Europe, public benefits revenues are usually referred to as earmarked funds, and the public benefits charges themselves are commonly called taxes instead of charges. A number of countries, including Denmark and Belgium. have implemented a charge on electricity rates to fund energy-efficiency programs. The Danish Energy Trust is financed by a special energy savings charge of Danish krone 0.006/kWh (0.0011 USD/kWh) payable by households and the public sector. Total annual proceeds amount to approximately Danish krone 90 million (USD 16.4 million) (Danish Energy Saving Trust, 2009). In the Netherlands, an energy tax on electricity was accompanied by a tax rebate for buyers of energy-efficient appliances under the Energy Premium Scheme. The cost for the EPR amounted to 65 million Euro in 2000 (USD 88 million) and 135 million Euro in 2001(USD 184 million) (Siderius and Loozen 2003)

In India, the Maharashtra Electricity Regulatory Commission instituted a public-benefits type of electricity charge on utilities, funds from which can be used to finance renewable-energy and energy-efficiency programs in the state. MERC ordered utility companies in the state to use these resources to start compact fluorescent lamp (CFL) programs in the residential sector in Mumbai and in the Nasik District in late 2005 (Sathaye et al. 2006).

Market Based

The costs of energy-efficiency measures undertaken to meet targets set by regulators are generally passed through in energy prices. This is done explicitly when a regulated distribution charge is implemented on energy prices as has been done in Italy. In other cases, such as the UK, this charge is implicit. Price impacts in the UK have been estimated at approximately 1.5% (Eyre et al. 2009). Although French law stipulates that implementation costs are taken into account in price changes regulated by the government, no increase has been earmarked to the French white certificate market. Moreover, the energy savings during the first phase of the French program have been largely met by government tax credits offered to residential customers for installing more efficient heating equipment, which has lowered the program cost for the energy provider.

Direct Customer Charge

In some cases, utilities can offer energy-efficiency services as part of their business plans. In this case, the utility offers to pay a portion of customers' up-front costs for efficient equipment via a loan whose cost will be entirely borne by the costumer. Usually, the value of the energy savings equals or exceeds the annual payments that the customers must make to reimburse the loan cost plus utility services. The utility earns a profit by sharing a portion of the customer's energy savings. In this case, the utility acts as an ESCO, implementing and financing energy-efficiency projects and using the income stream from the cost savings to repay the costs of the project, including the costs of the investment.

The most significant examples of direct customer charge programs are the Pay As You Save (PAYS) programs implemented in some U.S. states (Cillo and Lachman 1999). Through this program, a customer's utility, energy supplier, a third-party capital provider (e.g., a bank), or a product vendor pays the up-front cost to purchase the equipment. Whoever supplies the capital is repaid (including financial costs) through the customer's monthly payment. To qualify for the PAYS program, a customer's monthly payment needs to be equal to or less than 75% of the energy that will be saved during 75% of the equipment lifetime.

In these cases, the FI is entirely funded by the customer and even yields a small profit to the utility or other capital provider.

Actors

Once a policy framework has been designed that sets objectives and funding mechanisms, policy makers need to decide who will have the responsibility of managing the fund and implementing energy-efficiency programs. Today, FI programs are administered by governments, independent agencies, utilities, or a combination of these entities. In a study by Kushler et al. (2004), nine of the 18 U.S. States studied relied on either government agencies or an independent non-profit organization, and the other half relied on utilities to administrate the programs (Kushler, York and Witte 2004). The following subsections give examples to illustrate both cases.

Utilities

Utilities may be required to invest in energy-efficiency programs for their customers. Energy utilities are often considered the best qualified to design and implement DSM programs because of their direct link to customers. Utilities have ready access to detailed information about customers' energy consumption patterns, which are needed in determining the most effective projects. In some countries, notably the U.S., utilities are often perceived by customers as reliable sources of information on energy-efficiency products and services. However, as a result of electricity market restructuring in the U.S. and elsewhere in the 1990s, the regulation mechanisms that govern DSM programs have evolved and are still experiencing adjustments. Unbundling of utilities caused integrated resource planning to become impractical, and the introduction of competition reduced retailers' interest in supporting demand reduction. Utilities have a financial disincentive to promote customer load reduction because electricity sales are their main source of revenue and profit. Therefore, new actors and/or new incentives were explored to foster resource-acquisition programs by utilities. Intense debates are currently taking place in the U.S. and Canada regarding the need to create incentives for utilities to implement efficiency programs (U.S. EPA 2007, EEWG 2008).

California was the first U.S. state to implement a regulatory mechanism that decouples utility revenues utilities from sales. The basic principle is that, once sales are realized, electricity rates are adjusted to guarantee a fixed revenue level to utilities independent of sales. California State regulators went one step further by setting rules so that utility companies can benefit from promoting and undertaking efficiency measures. Utilities are rewarded financially when they exceed the goal set by the regulator (Schultz and Eto, 2002). In this scheme utilities are encouraged to minimize the costs of meeting the energy savings targets and to save as much energy as possible. Other states in the US have implemented similar utilities incentives.

Independent Agencies

Administration of energy savings programs has evolved, and more programs are now being administered by non-utility entities than before. For example: in New York, the New York State Energy Research and Development Administration (NYSERDA), a non-utility entity, manage the fund collected by utilities through a public benefit charge and implement energy-efficiency programs. Similarly in Denmark an independent agency, the Energy Trust, was created to manage and implement energy-efficiency programs. The establishment of this agency was justified by the need to increase efficient use of resources in implementing energy-efficiency programs. There was also a need to introduce players with a different incentive structure than that of the electricity supply companies. Compared with government organizations, the Energy Trust enjoys a much higher degree of freedom and can more easily employ market-oriented initiatives, such as standard offers (Danish Energy Saving Trust 2009). In the case of where independent agencies are administrating energy savings programs, evaluation schemes need to be set up to ensure that implementation costs are minimized. Independent agencies also need access to information about energy consumption and consumer behavior that is usually available to utilities. Program evaluations to identify best practices can help improve the future effectiveness of programs.

Blumstein et al. (2003) describe five different models and their suitability for use in implementing energy-efficiency programs at the U.S. state level. They conclude that no single administrative structure for energy-efficiency programs is clearly superior to all of the other alternatives. Determinant parameters are that the government set clear mandates for program administrators, a dedicated budget, and long-term strategies. Moreover, policy makers need to establish proper incentives for program administrators so that the greatest potential energy savings are realized in a cost-effective manner.

Types of Incentives

A multitude of programs have been developed by program administrators to save energy. Some involve a direct payment or subsidy to consumers or manufacturers, others use indirect payments, and some use financial instruments to subsidize for up-front cost normally borne by consumers. The following subsections describe these different programs and provide examples from various countries.

Direct Subsidies

Tax incentives

Income tax credits or tax deductions are a very popular form of FIs implemented by governments across countries. These are generally proposed by public administrations, such as energy ministries or government environmental agencies. Governments offer to reduce the expense of purchasing energy-efficiency systems by offering tax credits or tax deductions. A tax credit reduces the taxes the consumer pays, and a tax deduction lowers the consumer's taxable income. The percentage of the credit or deduction varies by country and generally has a maximum limit. Other popular types of tax incentive reduce sales tax on energy-efficient equipment purchases, either via a direct reduction or a refund.

Many European countries have implemented tax incentives for home insulation and heat systems. For example, more than 1.2 million households French households benefited from a residential-sector efficient heating program in 2007 (French Ministry of Sustainable Development, 2009a). However, only a few countries have implemented tax incentives directed toward appliances. Italy, for example, has been successfully granting tax deductions to buyers of A+ refrigerator since 2007 (Attali et al. 2009). In the UK, the incentive reduces sales tax from 17.5% to 5% for the purchase of qualifying energy-efficient equipment.

Rebates

Two types of rebate programs have been implemented by energy-efficiency program administrators: downstream rebates directed to consumers and upstream rebates directed to retailers and manufacturers.

Consumer rebate programs are a very popular tool implemented by U.S. utilities. Of more than 1,390 FI programs reported in the DSIRE database, 76% are rebate programs. Consumer rebate programs give consumers a price reduction to purchase new energy-efficient appliances when they replace used appliances. In Europe, rebates are more often called grant subsidies and are also implemented as a means to spur the penetration of high-efficiency appliances. Countries where this type of incentive is common are Switzerland, Denmark, the Netherlands , and the UK (Attali et al. 2009). In the UK, enhanced capital allowances have been granted to buyers of lighting and cooling equipment, boilers, and motors.

Upstream and midstream incentives consist of rebates directed to manufacturers or retailers who produce and sell qualifying high-efficiency appliances. The rationale is that these programs influence a large portion of the market, limit administrative costs, accelerate the introduction and sale of efficient equipment models, and can have spillover effects to other appliances (e.g., compressors used in both air conditioners and refrigerators). Upstream incentives are efficient and effective because they motivate distributors to sell and producers to produce energy-efficient equipment. These incentives can impact the percent of energy-efficient products in a category. Upstream incentives reduce customer initial cost, increase product availability at the retail level, and strongly influence manufacturers to improve product quality. This type of incentive also tends to increase in effectiveness when only a few large manufacturing companies are present in and able to supply all countries (i.e., where the market is globally uniform such as for TVs).

An example of upstream incentives is the California "Upstream [Heating, Ventilating, and Air-Conditioning] HVAC Distributor Rebate Program," launched in 1996. The program provides cash subsidies to retailers for selling high-efficiency HVAC equipment. The program's two goals are to encourage increased stocking and up-selling (i.e., explaining the technical benefits to customers and calculating return on investment) of high-efficiency HVAC equipment. A recent evaluation conducted by Kema (2010) of the 2006-2008 Upstream Lighting Program implemented by the Californian investor-owned-utilities estimates statewide annual net savings to be about 1,325 gigawatt hour while net peak savings were determined to be nearly 134 megawatts. Screw-in CFLs account for the vast majority of net savings.

Another example is China's CFL promotion program, launched in 2008 to increase the use of energy-efficient light bulbs. The light bulb program is the first financial subsidy program used in China to promote the penetration of energy-efficient products. Subsidies are offered to suppliers to provide a 30-percent discount on wholesale purchases and a 50-percent discount on retail sales. A total of 210 million subsidized CFLs were sold to consumers between 2008 and 2009, which resulted in an estimated savings of 8.8 billion kWh of electricity each year. In June 2009, the Chinese government extended the incentive program to air conditioners. The central government offers subsidies of 500-850 renminbi (RMB) (USD 72 to 122) per unit for the mostly highly efficient products rated as grade 1 in the Chinese label system and 300-650 RMB (USD 45 to 95) per unit for grade 2 air conditioner products. Local governments are encouraged to provide additional subsidies. By early February 2010, about 5 million energy efficient air conditioners had been subsidized, which equals a reduction of 1.5 billion KWh of electricity. In May 2010, the Chinese government extended the incentive program to other products by allocating over 400 billion RMB ($60 billion) annually to promote domestic demand for energy-efficient products including refrigerators, washers, TVs, automobiles, electric motors, and gas heaters (Wang 2010, Yu 2010).

Early Retirement Programs

Early retirement and direct install programs involve replacing inefficient residential appliances before the end of their useful lives with significantly more efficient appliances. This reduces electricity use as more efficient units deliver the same energy service with less input energy. The key difference with generic "rebate" programs is that direct install programs pay for entire cost of the energy efficiency measure, rather than just a portion. The economic feasibility of early replacement depends on the vintage of the unit being replaced, the installed cost of the new unit, and the energy savings. These programs are often directed at low-income households where the distribution of old appliances is much greater. Besides the energy-efficiency benefits, the attractiveness of programs that replace old equipment is that they provide opportunities for old appliances to be recycled by the local sanitary service in accordance with the environmental regulations and practices. In the case of old refrigerators that use chlorofluorocarbons (CFCs), a further benefit is compliance with the Montreal Protocol for removing CFCs.

The U.S. has extensive experience with energy-efficiency programs for low-income consumers. The Low Income Home Energy Assistance Program offers early-replacement programs for many different appliances. Many U.S. utilities offer similar programs,

Another example of an early replacement program is Mexico's Programa Nacional de Eficiencia Energética (Salaverría 2010, Sener 2010). The program offers government-funded subsidies to low-income consumers to replace their old refrigerators with new, more efficient models. The subsidies cover a portion of the price of the new appliance and also a portion of the transportation, storage, and disposal costs involved in removing and replacing the old appliance. In order to receive the subsidy, consumers are required to surrender their old, functioning refrigerators. Participating retailers are able to sell refrigerators at the subsidized price and then receive the difference from the utility upon verification that the appliance is sold to a subsidy-eligible customer. Removal of the old machines created the need for centers for storage and destruction (CAyD) of the old refrigerators. CAyDs have the capacity to discard refrigerators in compliance with Mexican environmental law, which requires special procedures to dispose of, for example, CFCs. In addition to ensuring environmentally sound removal of refrigerators from the national stock, the program has resulted in the recovery of copper (170,000 kilograms) and aluminum (300,000 kilograms) from returned appliances.

Indirect Subsidies

The consumer reward systems developed in Korea and in Japan are an innovative tool aimed at promoting low-carbon lifestyles by raising consumer responsibility and awareness. The system awards carbon points to consumers for every high-efficiency electronic and electrical appliance they buy. These points can then be redeemed for discounts in price or cash.

Korea launched the "Carbon Cashbag" in October 2008. Points are stored on a Carbon Cashbag card and can then be used for discounts on public transportation, basic utilities charges, purchases of other appliances, or tickets to cultural events. One carbon point equqls to 3 won (0.25 cents USD). The system covers 33 electronic goods. It is a voluntary program; companies that register benefit from reductions in advertising fees and other public incentives (IEA 2008). The system is divided into one program organized by the Ministry of Environment and others customized by local governments. As of October 2010, a total of 1.5 million households, about 8.8% of all households in Korea, are registered in one of the consumer rewards program. However, participation rates for many regions are still below 5%. The federal government provides 50% of the budget for the incentives, and 50% comes from local government. A similar program has been implemented in Japan called the Eco-Point System (described in an earlier section).

Subsidized Loan

Access to capital through subsidized low- or zero-interest loans is an important strategy for motivating energy-efficiency investment. Loans cover the up-front cost of purchasing energy-efficient equipment, and the energy savings offset the consumer's cost to repay the loan over time. Loans give customers the opportunity to reduce energy use without paying the up-front capital costs. Loans can be offered by governments, independent agencies, utilities, or third-party financing institutions like ESCOs or banks. They can also be part of innovative packages that make a loan more attractive. The following subsections describe the most common types of loans.

Low-interest government loans

Several countries offer low-interest loans for a broad range of renewable energy and energy-efficiency measures. These programs are commonly available for the residential sector. Loan rates and terms vary by program. In many countries, governments work with financial institutions to establish loan guarantee funds for efficiency investments. They can also help co-finance loans to encourage loan availability.

Property-assessed clean energy (PACE) financing

Property-assessed clean energy (PACE) is an innovative instrument that links the cost of the energy-efficient equipment to the value of the home. Through these programs, local governments offer low-interest loans to property owners to help pay the up-front costs of permanent energy improvements to the property. Installation of the efficient device increases the property value and therefore increases the property tax, which pays off the loan. The most interesting part is that if the property owner moves or sells the property before the loan is paid back, the remaining balance is transferred to the new owner. Thirteen U.S. states have enacted legislation enabling local governments to create PACE programs during the last year (DSIRE 2011). The UK government has recently launched "green loans" that are also tied to the house rather than a person. This type of program has the added value of tying the cost of the program to the current beneficiary rather than a past beneficiary.

On-bill financing

On-bill financing programs allow consumers to spread out the up-front cost of buying energy efficient appliances by paying them off on monthly electricity bills. The utility pays for the efficient equipment and then recoups the cost gradually over time through the customer's monthly bill. For the customer, the additional cost on his or her bill is offset to some degree by the energy savings. Two different approaches to these programs are loans or tariffs. A loan is assigned directly to the customer who must pay it back even if he or she moves. In contrast, the tariff links the charge to the meter, meaning that whoever lives at the house or owns the business pays the fee, similar to the structure of the PACE program described above. The tariff approach has the advantage of encouraging renters to participate because they only pay for energy saving measures while they continue to live at the property and benefit from the efficiency measures. For customers, an advantage of on-bill financing is that the cost of the improvements and the post-improvement savings cancel each other out on the same statement. However, this complicates the utility's billing and requires billing system modifications. Currently, this program design is only available in a few U.S. states and is still in an early stage of development (Brown 2009).

ESCO

ESCO activity in the residential sectors is very limited because of a number of barriers such as split incentives, small project sizes, and high transaction costs (Urge Vorsatz, Koeppel et al. 2007). However, ESCO activity can be stimulated by helping them access to capital and setting a regulatory framework for energy savings. . For example, in April 2010, China's central government issued a measure called "Opinions on Accelerating the Promotion of Energy Performance Contracting to Boost the Energy Service Industry," which provides new financial and tax incentives for ESCOs carrying out energy-performance contracting. Another example is the Italian white certificate scheme where as much as 75% of savings originated from ESCOs.

Measure of Success

Assessing how effective energy-efficiency policies have been requires first understanding the initial intended goal of the policy. Was it to remove the first-cost barriers that prevent customers from buying more efficient appliances? Was it to transform the market to increase penetration of more efficient appliance? Was it to influence the learning curve for a particular technology and allow it to mature faster and so reduce the price of high-efficiency appliances? Was it to provide more cash flow to customers to stimulate the broader economy? The measure of success depends on the initial goal or goals that were set by the policy maker.

To determine the effectiveness of a policy in achieving its goal, evaluators need access to concise information about the initial policy goal. The second step in an evaluation study is to assess how efficient a particular policy has been in achieving the original goal. In other words, is the policy in place achieving its goal with the lowest cost-benefit ratio? Cost-benefit ratio and cost/per unit energy saved are common measures of success for policies. However, use of such metrics requires that evaluators have access to detailed information on the savings implemented and a sound method of quantifying the value of the benefits and the cost of programs implemented. Finally, a comparison between the policy or program being evaluated and similar programs from different countries or states would be beneficial.

Impact evaluation needs to be part of the program planning process, including the alignment of implementation and evaluation budgets and schedules, so that it can provide critical evaluation results in a timely manner to support existing and future programs and adaptive learning by policymakers (NAPEE, 2007). According to the latest Consortium for Energy Efficiency's report, budgets for evaluation, measurement and verification varied between 0.1 and 22.5% of the total amount budgeted for electrical energy efficiency for 2009, with a median of 1.8% and an average of 2.8% (Caracino 2010). In California, the Public Utilities Commission approved a budget of $125 million or 4% of the overall portfolio budget for energy management and verification in 2010 through 2012 (CPUC 2005). The optimal evaluation management and verification budget level will vary among policies and countries. However, policy makers need to understand the necessity of carving out a portion of the program or policy budget to inform the continuation or discontinuation, expansion, reduction, or adaptation of a particular program or policy.

Impact Evaluation

A policy can target multiple objectives. Measuring whether a policy meets the intended objectives requires the development of specific indicators that vary according to the initial goal set by the policy makers.

Goal	Metric
Energy Savings	$/kWh, kWh avoided
GHG Savings	$/ton carbon dioxide
Market penetration	% penetration
Cost Reduction	% reduction/ year
Cost Savings	$ spent/$ saved
Job Creation	$/job created, number of jobs created

Energy Savings targets

The main goal of many of the policies reviewed in this paper is to achieve predetermined energy savings, often called "targets" in Europe and "goals" in the U.S. Energy savings goals or targets are set by the regulator for a predetermined period. These are often based on an energy savings potential study. When programs are implemented to meet the goal, ex-ante calculations of the savings are used to either verify compliance with the goal or to redeem white certificates. Standardized methodologies have been developed to account for energy savings in order to facilitate program implementation and to report savings in a homogeneous way. The most extensive source of energy savings estimates is the Database for Energy Efficient Resources (DEER) which also includes peak-demand savings, measure costs, effective useful life, and net-to-gross factors. The database include estimate for hundreds of technologies in residential and nonresidential applications. DEER has been has been designated by the CPUC as its source for energy savings estimates and impact costs for program planning. Similar standardized energy savings methodologies exist in Great Britain, Italy, and France. France has the largest number in Europe– 170 -- of standardized energy savings examples (Giraudet et al. 2011). The sum of the ex-ante savings from the potential multitude of measures implemented determines whether the initial goal was met. In all of European countries, targets have all been exceeded, by 44% for the second period Energy Efficiency Commitment... in Great Britain, by 20% during the first phase of the white certificate in France, and by 90% in the first 2 years of the program in Italy (Giraudet et al. 2011). Success in the U.S. states is less impressive. However, this might also reflect that goals are more stringent for energy providers in the U.S. as many states have implemented performance incentives for energy providers that reach their goals.

However, ex-ante energy savings estimates rely on a number of assumptions. Program evaluations are necessary to validate or modify these assumed parameters for the savings estimation calculations, in order to better reflect observed savings. Typically, assumptions are needed for the following parameters: equipment lifetime, market penetration rate, unit energy consumption, equipment size, hours of use and net to gross ratio. The most significant challenge is to estimate the net to gross ratio, i.e., the percentage of energy savings strictly attributable to the policy being considered. For example, energy savings estimates need to exclude savings from participants that would have undertaken the energy-efficiency activity in the absence of the program (Free riders) and include savings from nonparticipant programs that resulted from the influence of the program (spillovers). Savings estimates also need to exclude the demand-reduction effects of other programs such as standards and labeling, building codes, and other FI policies. This can be particularly difficult when, for example, different entities such as utilities and state and federal governments offer FIs to the same set of consumers for the same appliance. Evaluators should attempt to disaggregate the effect of such multiple incentives where possible, and decision makers should attempt to identify such overlaps in policy to the extent possible. Other considerations include the effect on energy use of the “rebound” effect, i.e., the effect that realizing greater savings may encourage customers to use more energy.

A recent evaluation of the Upstream Lighting Program (ULP) in California, conducted on behalf of the CPUC, shows that net savings from each bulb were only 25% of what was expected when the CPUC approved the program. Notably, the ex-post evaluation reports that program savings were overestimated by 15% because of CFLs that were in customers’ homes but had not yet been installed, i.e. a kind of ”hoarding” by consumers in anticipation of the future removal of such an incentive. Such evaluation of this program is critical because it accounts for 56% of the net expected energy savings from the portfolio of programs run by electric utilities during the three-year program period 2006-2008 (Kema 2010). Moreover, the understanding gained can allow the utility and the regulator (in this case the CPUC) to implement policy corrections such as, in the instance of hoarding, limiting the number of CFLs per customer, or implementing the program as a one-for-one replacement program.

The ULP evaluation also showcased the difficulty of attempting to analytically separate the effect of a policy from natural market movements in the absence of such policy. For example, recent criticism of the evaluation of the ULP focused on how the evaluation accounted for the fraction of program savings that the authors claimed would have occurred even if the policy had not been implemented. The authors of the evaluation report recommended a final 54% ”Net to Gross Ratio,” which represented this fraction of savings, based on the authors’ ”best judgment” rather than on market data. The authors were not able to begin data collection until 2 years after the implementation of the program (NRDC 2010).

Other Objectives

FIs can be implemented with objectives other than just energy savings. For example, policy makers often set a goal of market transformation (i.e., replacing a market for inefficient appliances with a market for efficient appliances). In other cases, policy makers want to stimulate job creation, reducing the price of new technologies, boost domestic demand, and spread information diffusion energy efficiency potentials. In some developing countries, FI goals can include efforts to regularize illegal electrical connections or phase out subsidies without negatively impacting the ability of low-income consumers to pay bills (Januzzi 2007). For a utility, this can involve reducing problems related to power supply system bottlenecks. In all of these cases, meaningful indicators need to be developed to assess the effectiveness of the policy.

Cost-Effectiveness Analysis

The costs of reducing consumption are a major concern for policy makers. However, measuring the success and calculating the cost effectiveness of energy-efficiency programs are very challenging tasks. Cost-effectiveness analyses assess the ratio of dollars spent per unit of energy saved and are typically considered an extension of impact evaluations. According to Arimura, Newell, and Palmer (2009), estimates of cost effectiveness of past U.S. DSM programs, measured as cost per kWh saved, range from just below 1 cent per kWh saved to more than 20 cents. However it is important to note that many parameters enter into the cost benefit analysis equation, notably the discount rate, which is used to calculate the present value of future savings from the measure implemented, and the perspective adopted; for example, is the goal to assess cost effectiveness from the perspective of the consumer, the utility, or society? Discount rates can range from 3% to more than 20% depending on the approach taken. In California, different tests have been developed to reflect this difference (State of California. 2001; NAPEE, 2008).

Side Effects and Unintended Consequences

In an evaluation assessment, it is also essential to assess the side effects (both costs and benefits) or other unintended consequences that may result from the implementation of a policy, so that decision makers have adequate information to determine whether to expand, limit, adapt, or continue the program or policy. For example, impacts on peak electricity load (e.g., in the case of air conditioners), GHG emissions, jobs, public health (e.g., mercury from CFLs), water usage and equity may need to be assessed. In ratepayer-funded programs, the costs of implementation are generally evenly distributed across consumers. However, the benefits from energy savings can be unevenly distributed (Eyre et al. 2009). Evaluation studies need to assess the effects of cross subsidies and recommend remedies where desirable and possible.

Potential Comparison

Programs vary considerably in scale, target-setting methods, target size, concerned parties, energy-using sectors covered, and length of time during which they have been operating. Most notably, we found that the units in which energy savings targets are reported differ widely among countries. For example, in California, the CPUC goal is expressed in annual savings accumulated during the three-year program period. In the French case, the target is expressed in cumulative lifetime savings, which includes aggregated savings accrued over the expected life of a measure installed during the program period. In the French case, the measure-life multiplier becomes a determinant parameter for the energy savings estimate, which adds uncertainties to the estimation. However, it gives more weight to measures that have a longer life. Additionally, inconsistencies exist among countries with regard to whether savings can be reported at the net customer meter level or the net generator level (accounting for transmission and distribution line losses). When introducing uncertainty, policymakers should try to use transparent assumptions, to allow potential conversion and comparisons.

Conclusion:

FI programs are among the most effective policies used to manage the growth of electricity demand. FI programs are used to increase the penetration of efficient end use equipment and serve as a cost-effective alternative to building new power supply. The rationale is that the up-front costs of implementing energy-saving measures are recouped as energy savings accrue. For utilities overall, the implementation cost is justified as long as it is less than the value of the energy saved. Governments may account for additional benefits such as jobs, public health or environmental benefits, and therefore may justify an even higher implementation cost. Regulatory frameworks used by policy makers to stimulate the implementation of FI measures are innovative and diverse from country to country. Over the last 5 years many European governments have launched white certificate schemes and many other European countries are seriously considering it. Moreover, countries, like China and South Africa, are currently developing the regulatory framework to implement FI.

The up-front costs of program implementation can be recovered through taxes or other general government funds or directly through the price of electricity. Most countries use both policy mechanisms to promote energy efficiency. The first type of action is similar among countries, but policy mechanisms that raise funds through electricity rates vary widely among countries from levying public benefit charges as is done in many U.S. states to designating a percentage of utility revenue to be spent on energy efficiency, as in Brazil, to setting energy savings price, as in South Africa. Governments have been innovative in establishing mechanisms for implementing energy-efficiency programs.

Program implementation can be administered by utilities, independent agencies, or both at the same time. There are benefits to each type of implementation. The critical aspect for best results is that FI program administrators be supported by governments through clear mandates, a dedicated budget, and long-term strategies. In the case of utilities, policy makers need to establish proper incentives so that potential energy savings are realized in a cost-effective manner and at their maximum potentials, for example by rewarding utilities when they exceed goals. In the case of independent agencies, evaluation schemes need to be set up to ensure that implementation costs are minimized. Independent agencies also need access to information about energy consumption and consumer behavior that is usually available to utilities. Program evaluations to identify best practices can help improve the future effectiveness of programs.

FI programs are varied in design, implementation, and policy framework. They should be designed carefully, taking into account their objectives, the characteristics of the customers targeted (behavior, cultural differences, income levels), timing, involvement of the various stakeholders (retailers, utilities, etc.), and the potential downsides (such as cross subsidization, rebound effects and promoting sales of larger appliances). Program evaluation and adaptive implementation are necessary to make sure programs are effective and efficient in achieving their goal.

The variety of FI programs that have been implemented across the world is a very interesting a topic of analysis. More work is needed to better understand how each program design, implementation, and policy framework are better suited for particular goal set by policy makers. Context of policy programs implementation and customer preferences also needs to be studied in more detail to better portray best practices. Initiatives such as SEAD that aim to facilitate cross-country collaboration and sharing of best practices for market transformation are venues in which information about FI can be utilized effectively.

References

ACEEE. 2011. "Efficiency Potential and Market Analysis." webpage accessed March 15, 2011. https://www.aceee.org/topics/efficiency-potential-and-market-analysis

Arimura T. H., R. G. Newell, and K. Palmer. 2009. "Cost-Effectiveness of Electricity Energy Efficiency Programs." *Resource for the Future*, RFF DP 09-48. November.

Attali, S., E. Bush, S. Michel. 2009. *Factors influencing the penetration of energy efficient electrical appliances into national market in Europe*. Report for Defra / the Market Transformation Programme by SoWATT and Bush Energie Gmbh. Paris. June.

Blumstein, C., C. Goldman, and G. Barbose. 2003. Who Should Administer Energy-Efficiency Programs? Berkeley CA: Center for the Study of Energy Markets Working Paper 115.

Brown M. 2009. "Brief #3: Paying for Energy Upgrades Through Utility Bills." Alliance to Save Energy. http://ase.org/resources/state-energy-efficiency-policy-briefs.

Caracino J., M. Nevius, and L. Fesler. 2010. "State of the Efficiency Program Industry, 2009 Expenditures, Impacts & 2010 Budgets." Consortium for Energy Efficiency. December 10.

California Public Utilities Commission (CPUC). 2010. Proposed Decision of Alj Gamson (Mailed 3/9/2010) before the CPUC.

Cillo Paul A. and Harlan Lachman, 1999. "Pay-As-You-Save Energy Efficiency Products: Restructuring Energy Efficiency." The National Association of Regulatory Utility Commissioners, 1999. http://www.paysamerica.org/EEI_Pays_1st_paper.pdf

Danish Energy Saving Trust. 2009. "Description of the Trust's work, background notes." www.savingtrust.dk

DSIRE. 2011. Database of State Incentives for Renewable Energy. www.dsireusa.org

Eyre, N., et al. 2009. *Energy company obligations to save energy in Italy, the UK and France: what have we learnt?* European Council for Energy-Efficient Economy, Summer Study 2009, La Colle Sur Loup, France.

Energy Efficiency Working Group (EEWG), 2008. "Institutional and Regulatory Barriers to Utility Demand-Side Management in Canada", EEWG Issue Paper, Issue Paper Five, Energy Efficiency Working Group, Energy Sector Sustainability Table, November 2008. http://www.sst.gc.ca/Publications/Energy_Efficiency_Working_Group-WSED717E3F-0_En.htm

Eto, J., C. Goldman, and S. Nadel, 1998, "Ratepayer-Funded Energy-Efficiency Programs in a Restructured Electricity Industry: Issues and Options for Regulators and Legislators", LBNL-41479. May 1998

French Ministry of Sustainable Development, 2009a. "Plan climat de la France : Mise en oeuvre du grenelle Environnement", Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer, en charge des Technologies vertes et des Négociations sur le climat, page 37. http://www.developpement-durable.gouv.fr/IMG/pdf/09003_PLAN_CLIMAT.pdf

French Ministry of Sustainable Development (Ministère du Développement durable). 2009b. "Rapport sur le fonctionnement du dispositif des certificats d'économies d'énergie." Direction générale de l'énergie et du climat. May. http://www.developpement-durable.gouv.fr/IMG/pdf/Rapport_Fonctionnement_CEE_-uniquement_mise_en_ligne--1_cle2adad7.pdf

Finamore B., M. Yew, and B. Ho. 2010. "Taking Action to Meet its Climate Pledge - China Enacts National Energy Efficiency DSM Regulations to Dramatically Scale Up Investments in Energy Efficiency." *http://switchboard.nrdc.org/blogs/bfinamore/taking_action_to_meet_its_clim.html*

Giraudet L.G. L. Bodineau, and D. Finon. 2011. "The Cost Benefits of White Certificate Schemes. " Working Papers no 29-2011, Centre International de Recherche sur l'Environnement et le Développement (CIRED). March.

Golove, W. H. and J. H. Eto. 1996. *Market Barriers to Energy Efficiency: A Critical Reappraisal of the Rationale for Public Policies to Promote Energy Efficiency*. Berkeley CA: Lawrence Berkeley National Laboratory, Report LBL-38059.

International Energy Agency (IEA). 2010. *Energy Efficiency Governance*. http://www.iea.org/papers/2010/eeg.pdf

Independent Pricing and Regulatory Tribunal (IPART). 2008. "Compliance and Operation of the NSW Greenhouse Gas Reduction Scheme during 2007." Report to Minister, New South Wales. July.

Independent Pricing and Regulatory Tribunal (IPART). 2010. "Compliance and Operation of the NSW Energy Savings Scheme during 2009." Report to Minister, New South Wales. July.

Intergovernmental Panel on Climate Change (IPCC). 2007. *Climate Change 2007 - Mitigation of Climate Change: Contribution of Working Group III to the Fourth Assessment Report of the IPCC*. Cambridge: Cambridge University Press.

Jollands N., P. Waide, M. Ellis, T. Onoda, J. Laustsen, K. Tanaka, P. de T'Serclaes, I. Barnsley, R. Bradley, and A. Meier. 2010. "The 25 IEA energy efficiency policy recommendations to the G8 Gleneagles Plan of Action." *Energy Policy*, Volume 38, Issue 11, November, pp. 6,409-6,418.

Jannuzzi, G. 2007. "Short term task order – fast response technical expertise to egat/i&e cost-benefit analysis of a refrigerator replacement program for low-income households in Brazil." January.

Kema. 2010, Final Evaluation Report: Upstream Lighting Program Evaluation Report, Volume 1. Cadmus Group, Inc., with KEMA, Inc. February 8. http://www.energydataweb.com/cpucFiles/18/FinalUpstreamLightingEvaluationReport_2.pdf

Koomey, J. and C. Richey. 1998. *Analysis of Tax Credits for Efficient Equipment, 1998*. Lawrence Berkeley National Laboratory, Energy End-Use Forecasting Group. http://enduse.lbl.gov/Projects/TaxCredits.html accessed March 2011.

Kushler, M., D. York, and P. Witte. 2004. *Five Years In: An Examination of the First Half-Decade of Public Benefit Policies*. American Council for an Energy Efficient Economy.

MacRae L., E. Jacobsohn, and C. Cloutier. 2010. *The State Energy Efficient Appliance Rebate Program: An Assessment*, 2010 ACEEE Summer Study on Energy Efficiency in Buildings. August.

McNeil, M. A., V. E. Letschert, and S. de la Rue du Can. 2008. "Global Potential of Energy Efficiency Standards and Labeling Programs." Lawrence Berkeley National Laboratory for Ministry of Economy, Trade, and Industry (METI). Available at http://ies.lbl.gov/gedc.

Japan Ministry of Economy, Trade, and Industry (METI). 2010. "Implementation Status of the Program to Promote the Spread of Green Home Appliances by Utilizing Eco-Points (as of the end of June)." Media Release. July 13th. http://www.meti.go.jp/english/press/data/20100713_01.html

Moskovitz, D., F. Weston, and J. Lin. 2007. Meeting China's Energy Efficiency and Environmental Goals with Efficiency Power Plants (EPPs). Report of Regulatory Assistance Project. June.

Nadel, S., and M. Kushler. 2000. "Public Benefit Funds: A Key Strategy for Advancing Energy Efficiency." The *Electricity Journal* 13 (8):74-84.

National Action Plan for Energy Efficiency (NAPEE), 2007, "Model Energy Efficiency Program Impact Evaluation Guide", Prepared by Steven R. Schiller, Schiller Consulting, Inc. http://www.epa.gov/eeactionplan

National Action Plan for Energy Efficiency (NAPEE), 2008. Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers. Energy and Environmental Economics, Inc. and Regulatory Assistance Project. <www.epa.gov/eeactionplan>

Salaverría, D.P.A. 2010. *Evaluación Ambiental y Plan de Manejo Ambiental del Programa de Eficiencia Energética Coordinado por la Secretaría de Energía: Informe Final* (SENER, KfW Group, World Bank, April). http://www.energia.gob.mx/res/722/EAyPMACorregido100610_Final.pdf.

Sathaye, J. and S. Murtishaw. 2004. *Market Failures, Consumer Preferences, and Transaction Costs in Energy Efficiency Purchase Decisions*. California Energy Commission Consultant report No. CEC-500-2005-020.

Sathaye, J., S. de la Rue du Can, S. Kumar, M. Iyer, C. Galitsky, A. Phadke, M. McNeill, L. Price, R. Bharvirkar, and S. Padmanabhan. 2006. "Implementing End-use Efficiency Improvements in India: Drawing from Experience in the US and Other Countries". Berkeley CA: Lawrence Berkeley National Laboratory, Report LBNL-60035.

Schultz D. and J. Eto. 2002. "Carrots and sticks: Shared-savings incentive programs for energy efficiency". The Electricity Journal, Volume 3, Issue 10, December 1990, Page 32

Sener. 2010. "Programa de Sustitución de Equipos Electrodomésticos para el Ahorro de Energía: Tipos de Apoyos." SENER, n.d., http://www.sener.gob.mx/webSener/pse/apoyos.html.

Siderius, H-P. and A. Loozen. 2003. *Energy Premium Scheme (EPR) for domestic appliances in the Netherlands.* European Commission for an Energy-Efficient Economy 2003 Summer Study.

State of California. 2001. "California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Policies". Sacramento, CA: Governor's Office of Planning and Research. http://www.energy.ca.gov/greenbuilding/documents/background/07-J_CPUC_STANDARD_PRACTICE_MANUAL.PDF

Taylor, R.P., C. Govindarajalu, J. Levin, A. Meyer, and W. Ward. 2008. *Financing Energy Efficiency: Lessons from Brazil, China, India, and Beyond*. Washington, DC: World Bank and International Bank for Reconstruction and Development (IBRD). www.indiaenvironmentportal.org.in/files/financing-energy.pdf

Ürge-Vorsatz, D., & Koeppel, S., 2007, "An assessment of policy instruments for reducing GHG emissions from buildings", Report for the UNEP Sustainable Buildings and Construction Initiative.

U.S. Environmental Protection Agency (US EPA), 2007. "Aligning Utility Incentives with Investment in Energy Efficiency", National Action Plan for Energy Efficiency, prepared by Val R. Jensen, ICF International. www.epa.gov/eeactionplan

Wang, G. 2010. *Energy Efficiency Progress in China*. Presentation made at 35th EGEE&C Meeting, Wellington, New Zealand, April.

Yu, Y. 2010. "Policy redesign for solving the financial bottleneck in demand side management (DSM) in China." *Energy Policy*, Volume 38, Issue 10, October, pp. 6101-6110.

Acronyms

ARRA	American Recovery and Reinvestment Act
CPUC	California Public Utilities Commission
DSM	demand-side management
EERS	Energy-Efficiency Resource Standards
ESCO	Energy Services Company
FI	financial incentive
GHG	greenhouse gas
HVAC	heating, ventilation, and air conditioning
kW	kilowatt
kWh	kilowatt hour
PACE	property-assessed clean energy
RMB	renminbi
SEAD	Super Efficient Appliance Deployment
UK	United Kingdom
U.S.	United States

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